

Suitability Modeling at Prince William Forest Park

Paul Petersen
GIS Technician
Prince William Forest Park

Prince William Forest Park is a woodland area consisting of 14,143 acres of mixed Piedmont Forest and Coastal Plain habitat. The park, located in the Quantico Creek Watershed in Northern Virginia, has many valuable resources which include: 37 miles of hiking trails, an advanced orienteering course, overnight lodging at Recreational Vehicle/Trailer sites, tent camping and cabin camp facilities, diverse flora and fauna, and some of five historic districts.

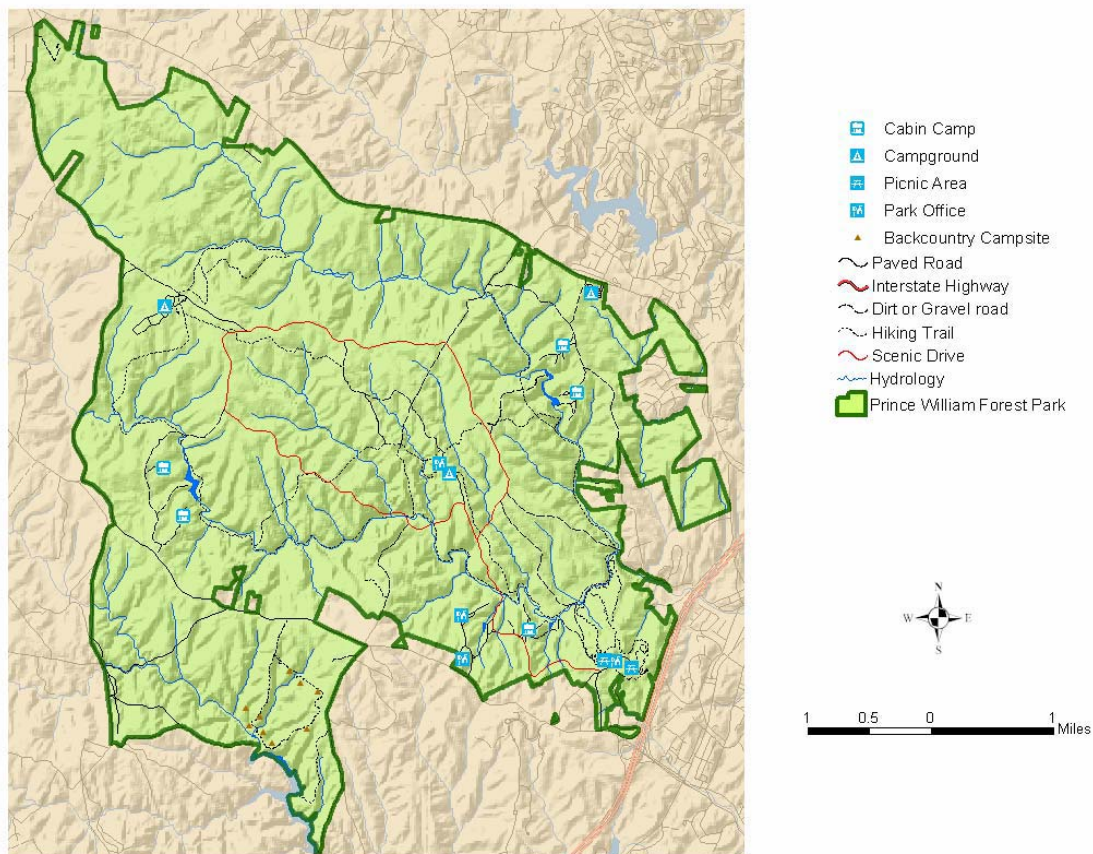


Figure 1

The combination of resources contained within the boundary of the park consistently challenge park management to create a balance between resource use and protection. In this challenging management environment, the use of Geographic Information Systems (GIS) has become a crucial tool that allows managers to use spatial data to make better informed management decisions. GIS plays an integral role in management decisions made in all program areas including resource protection, cultural resources, maintenance, natural resources, and visitor services (Interpretation).

The park's GIS Program maintains and updates a GIS database consisting of numerous datasets. These include raster datasets, such as aerial photography, digital raster graphs, digital line graphs, and a digital elevation model. A majority of resource data is stored in vector format and includes shapefiles and coverages from on-screen digitized data and survey data gathered via a Global Positioning System (GPS) unit. Data relating to integrated pest management (IPM), vegetation types, soil types, hydrology, hypsography, park structures, park regions, fire history, Natural Heritage Areas, old home sites, cemeteries, and other resources is represented in vector format. An average of two to four park employees access this data on a daily basis.

Trail Suitability and the Sensitive Area Model (SAM)

One example of how GIS is being used to support management decisions is the analysis of present and future trail route scenarios at Prince William Forest Park. GIS allows managers to quantitatively define resource and habitat sensitivity, making management decisions more defensible. In this case, the **Sensitive Area Model (SAM)** ArcView Extension, developed at Glacier National Park with contract support from ESRI's Olympia, Washington office, was used to identify resource sensitivity for the establishment or rerouting of trails through areas of low sensitivity. The analysis was conducted with the assumption that new roads or trails may be desired in the future. The relocation of existing trails was considered in this analysis since hiking trails are occasionally rerouted to avoid hazards created by flooding, leaning or downed trees, and other natural factors. In this study, inputs for the model were selected by managers and are represented in Table 1.

Theme	Category	Buffer (ft)	Weight 2
Table Mountain Pine	Sensitive Habitat	100	2
Eastern Hemlock	Sensitive Habitat	100	2
<i>Isotria medeoloides</i>	Sensitive Habitat	200	5
White Pine	Sensitive Habitat	100	2
<i>Carex vestita</i>	Sensitive Habitat	200	4
Seepage Swamp	Sensitive Habitat	500	5
Chopawamsic Backcountry Campsites	Visitor Use	2000	4
Campgrounds & Picnic Areas	Visitor Use	1000	3
Trails	Visitor Use	5000	3
Buildings-Historic Registry	Cultural Resource	1000	5
Pyrite Mine-Historic Registry	Cultural Resource	1000	5
Streams	Sensitive Habitat	100	2
Quantico Creek Headwaters	Sensitive Habitat	-----	3
Slope (above 25 degrees)	Sensitive habitat	-----	2
Park Boundary	Overlay Extent	-----	-----

Table 1

Model Data

Thematic data used for the analysis could be placed into three basic categories:

- 1) Sensitive habitat –unique habitats, tree species at the limits of their environmental range, rare plants species, streams, and areas with greater than a 25° slope*
- 2) Visitor Use – campgrounds, backcountry campsites, trails, and picnic areas
- 3) Cultural Resources – Areas listed on the National Registry of Historic Places including historic structures and five historic districts

All themes in the above categories were represented as polygon ArcView shapefiles, with the exception of the stream data, which is a polyline shapefile. Data was attained by the following methods: field surveys using a Global Positioning System (GPS) unit, surface analysis from ArcView 3.x tools, and on-screen digitizing of hardcopy map descriptions. In order to derive the slope data, surface analysis was done on a USGS 30-meter Digital Elevation Model (DEM) using the Spatial Analyst ArcView extension. The output of this analysis was a raster data theme interpreting the areas of the park which had slopes greater than 25°. The raster output was then converted to a shapefile in ArcView.

Model Parameters

In the model, thematic data are buffered and assigned weighted sensitivity values (See Table 1). The **buffer** value defines an area around the corresponding theme that will be included in the analysis. The **weight** is an assigned sensitivity value for the buffered area. In areas where two or more theme buffers overlap, the model assigns a sensitivity value equal to the sum of the overlapping themes. A good illustration of this concept is depicted in the vin

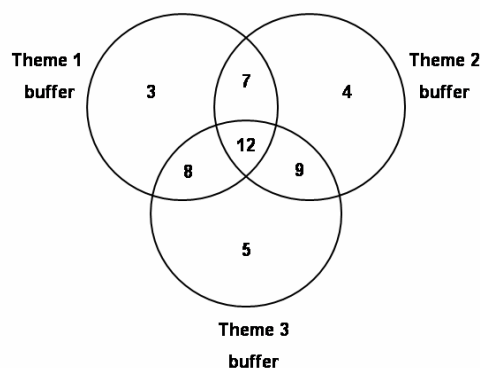


Figure 2

Diagram (Figure 2).

Buffering distance and weighted sensitivity values were developed in consultation with park resource managers. These values are a reflection of scientific analysis, practical knowledge of individual resources, and the understanding of park management goals. The weighted sensitivity values have no particular reference point or scale, except that they are integers equal to or greater than zero. In this case, the purposes of the weighted values are to identify a spectrum of sensitivity.

Model Output

Figure 3 is the display of an output from the Sensitive Area Model with the buffer and weight values from Table 1. Darker green to light green areas represent areas with lower sensitivity and yellow to red areas represent areas of higher sensitivity. The analysis results indicate that the bright yellow to red portions of the park may be unsuitable for further additions of roads and trails. High weighted values were assigned to areas where cultural, natural, and visitor resources are present, indicating the particular sensitivity of these sites.

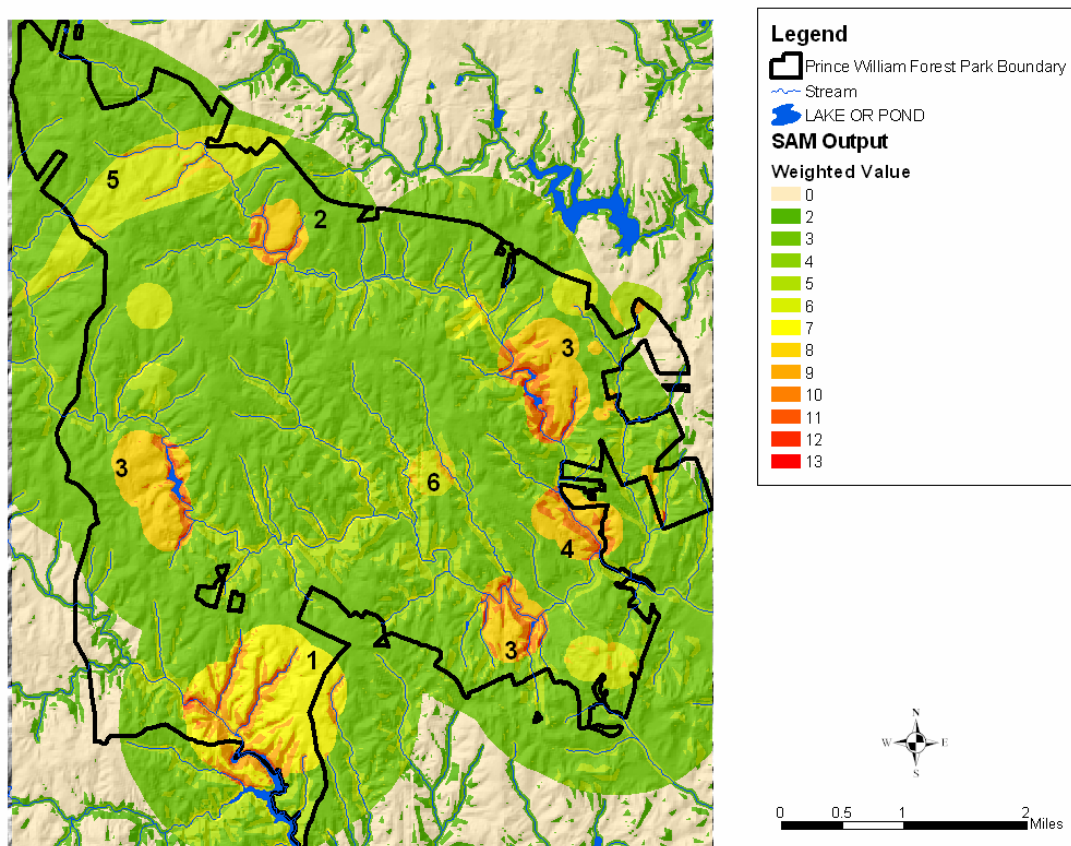


Figure 3

Analysis and Conclusion

Analysis of the results reveals five notable resource management issues. The numbering value below corresponds with the numbers placed on the map.

- 1) In the southwestern portion of the park, the Chopawamsic Backcountry Area, the model indicates a large area with weighted values ranging from 7 to 13. Steep drainages, trails, backcountry campsites and streams are the driving factors in the elevated weighted values. The southern border of the park abuts Quantico Marine Base, and the proximity of the sensitive Chopawamsic backcountry to the base may be an issue for park management.
- 2) In the north central portion of the park, the model displays a small circular area with above average to high weighted values of 8 to 12. This area is an oligotrophic saturated forest, or sometimes referred to as a “seepage swamp” or “seepage wetland”. It occurs at stream heads or alongside streams. Seepage swamps support unusual vegetation which occur in no other habitat. This intact seepage wetland and its underlying aquifer help maintain water quality in Quantico Creek’s adjacent streams. These unique qualities are valuable to the surrounding ecosystem and are documented natural heritage areas.
- 3) These three areas on the SAM output map are Civil Conservation Corps (CCC) cabin camps; built in the early 20th century. The camps are National Historic Sites which receive a high amount of visitor use. These areas have a moderate to high sensitivity, ranging from 8 to 12, because of the historic significance and their proximity to trails and streams.
- 4) Location 4 encompasses the Pyrite Mine, another cultural resource listed as a National Historic Site. Elevated sensitivity values in the range of 8 to 12 are due to the highly weighted values of Historic Sites, nearby trails, and the mines proximity to Quantico Creek.
- 5) The northwestern portion of the park has a weighted sensitivity that ranges from 2 to 10. The swath of land dividing this region, with weighted values from 6 to 10, is the headwaters for Quantico Creek, and is considered to be an important natural resource because of its impact on water quality. THE PARK is mandated to protect the headwaters of Quantico Creek in its enabling legislation. Also, the pristine quality of this region of forest is an invaluable resource to managers for research and conservation.
- 6) This small central site is the Turkey Run Ridge Group Campground and Turkey Run Education Center (TREC). This area has the highest elevation in the park and is popular with hikers because of numerous trail loops, an orienteering course, and its steep topography.

The Sensitive Area Model output quantitatively specified several areas of excessive sensitivity indicators in Prince William Forest Park. These locations were generally areas of densely clustered resources which generated

overlapping thematic factors in the model. Improvements of this model output would include factors such as water bodies (lakes and ponds) and additional cultural resources.

*The slope characteristic in the model is included to address possible soil erosion issues. The 25° value was chosen with practical knowledge of general soil characteristics; however, further analysis of specific soil characteristics is needed to remove the models bias.